#3

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Brian O'SULLIVAN, et al.

Appln. No.: 09/813,974 Group Art Unit: 2681

Confirmation No.: 6049 Examiner: Not Assigned

Filed: March 23, 2001

For: A METHOD AND APPARATUS FOR TRANSMITTING DATA FROM AN ANALOGUE MODEM TO A DIGITAL MODEM THROUGH AN ANALOGUE CHANNEL

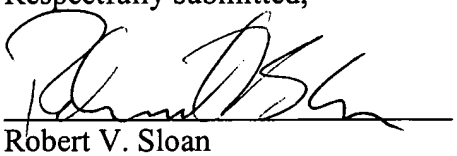
SUBMISSION OF PRIORITY DOCUMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Submitted herewith is a certified copy of the priority document on which a claim to priority was made under 35 U.S.C. § 119. The Examiner is respectfully requested to acknowledge receipt of said priority document.

Respectfully submitted,



Robert V. Sloan
Registration No. 22,775

SUGHRUE, MION, ZINN,
MACPEAK & SEAS, PLLC
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037-3213
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

Enclosures: Ireland S2000/0219

Date: June 14, 2001

09/813,974
Inventor: Brian O'Sullivan et al.
Filed: 3/22/01
Q63711

Patents Office
Government Buildings
Hebron Road
Kilkenny

I HEREBY CERTIFY that annexed hereto is a true copy of documents filed in connection with the following patent application:

Application No.	S2000/0219
Date of Filing	22 March 2000
Applicant	FERNWAY LIMITED, an Irish company of 63 Broomhill Drive, Tallaght, Dublin 24, Ireland.

Dated this 23 day of March 2001.

Coheirly

pp An officer authorised by the
Controller of Patents, Designs and Trademarks.

FORM NO. 1

S 000219

REQUEST FOR THE GRANT OF A PATENT

PATENTS ACT, 1992

The Applicant(s) named herein hereby request(s)

[ ] the grant of a patent under Part II of the Act

[x] the grant of a short-term patent under Part III of the Act

on the basis of the information furnished hereunder.

1. Applicant(s)

Name	FERNWAY LIMITED
Address	63 Broomhill Drive, Tallaght, Dublin 24, Ireland.
Description/Nationality	An Irish company

2. Title of Invention — "A method for correlating a constellation of analogue points with corresponding digital codec levels"

3. Declaration of Priority on basis of previously filed application(s) for same invention (Sections 25 & 26)

Previous filing date	Country in or for which filed	Filing No.

4. Identification of Inventor(s)

Name(s) of person(s) believed by Applicant(s) to be the inventor(s)

Address

CONTINUED OVER

5. Statement of right to be granted a patent (Section 17 (2) (b))

The applicant has derived the right to be granted a Patent from the inventors by virtue of a Deed of Assignment

6. Items accompanying this Request - tick as appropriate

(i) [x] Prescribed filing fee (£ 50.00)

(ii) [ ] Specification containing a description and claims

[x] Specification containing a description only

[x] Drawings referred to in description or claims

(iii) [ ] An abstract

(iv) [ ] Copy of previous application(s) whose priority is claimed

(v) [ ] Translation of previous application whose priority is claimed

(vi) [ ] Authorisation of Agent (this may be given at 8 below if this Request is signed by the Applicant(s))

7. Divisional Application(s)

The following information is applicable to the present application which is made under Section 24 -

Earlier Application No: .....
Filing Date: .....

8. Agent

The following is authorised to act as agent in all proceedings connected with the obtaining of a patent to which this request relates and in relation to any patent granted -

Name	**Address**
F.F. GORMAN & CO.	54 Merrion Square, Dublin 2, Ireland.

9. Address for Service (if different from that at 8)

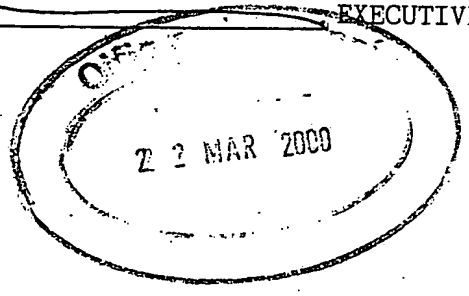
F.F. GORMAN & CO., at its address as recorded for the time being in the Register of Patents Agents.

F.F. GORMAN & CO., Agents for the Applicant

BY: _____ EXECUTIVE

Signed Name(s):
Capacity (if applicant is a body corporate) :

Date March 22. 2000



"A method for correlating a constellation of analogue points with corresponding digital codec levels"

The present invention relates to a method for correlating a constellation of analogue points with corresponding digital codec levels in a data transmissions system, and in particular, though not limited to the method for use in a data transmission system using a one dimensional constellation.

In telecommunication transmission systems between an analogue modem and a digital modem, when the distance between ADC levels is large compared to the distortion, a modulation scheme must take the levels into account. For example, in V.92, the analogue modem transmits a signal which is sampled, at the other end of the analogue channel, by the digital modem. These samples will have a level intended by the analogue modem plus added noise and/or distortion. The set of possible intended levels make up a one-dimensional constellation and the elements of the set are known as constellation points.

The present invention is directed towards providing a method for correlating a constellation of analogue points with corresponding digital codec levels in a data transmission system.

According to the invention, there is provided a method for correlating a constellation of analogue points with corresponding digital codec levels in a data transmission system, the method comprising selecting the constellation points so that the mid

point between pairs of adjacent constellation points of the constellation coincide with respective mid points between respective pairs of adjacent codec levels.

In one embodiment of the invention some of the constellation points may coincide with some of the codec levels.

In another embodiment of the invention none of the constellation points coincide with any of the codec levels.

In a still further embodiment of the invention each constellation point may coincide with a corresponding codec level.

Typically, there are more codec levels than constellation points, although, in one particular case the number of constellation points corresponds directly with the number of codec levels.

In a further embodiment of the invention the constellation is a one dimensional constellation.

In another embodiment of the invention the method is adapted for use in telecommunication transmission, and is particularly suited to a telecommunication transmission data system known as the V.92 standard.

Further the invention provides apparatus for correlating a constellation of analogue points of a constellation with corresponding digital codec levels in a data

transmission system, the apparatus comprising a means for selecting the constellation points of the constellation so that the mid points between pairs of adjacent constellation points of the constellation coincide with respective mid points between respective pairs of adjacent codec levels.

In one embodiment of the invention the means for selecting the constellation points selects the mid points between the pairs of adjacent constellation points so that some of the constellation points may coincide with some of the codec levels. Alternatively, the means for selecting the mid points between the pairs of adjacent constellation points select the mid points so that none of the constellation points coincide with the codec levels. In a further alternative embodiment of the invention the means for selecting the mid points between the pairs of adjacent constellation points selects the mid points so that each constellation point coincides with a corresponding codec level.

In one embodiment of the invention the number of constellation points is less than the number of codec levels, and in an alternative embodiment of the invention the number of constellation points is similar to the number of codec level.

In a further embodiment of the invention the apparatus is adapted for use with a one dimensional constellation, and preferably, is adapted for use with a telecommunication data transmission system.

The invention will be more clearly understood from the following description of an embodiment thereof which is given by way of example only with reference to the accompanying drawings in which:

Fig. 1 is a block representative of a telecommunication data transmission system according to the invention,

Fig. 2 illustrates a constellation of a constellation with the corresponding codec levels,

Fig. 3 similarly illustrates an alternative constellation of constellation points with the corresponding codec levels,

Fig. 4 similarly illustrates another alternative constellation of constellation points with the corresponding codec levels, and

Fig. 5 similarly illustrates a further alternative constellation of constellation points with the corresponding codec levels.

Referring to the drawings there is illustrated a telecommunication data transmission system according to the invention indicated generally by the reference numeral 1 for transmitting data between an analogue modem 2 and a digital modem 3. A codec 4 is located in the transmission path between the analogue modem 2 and the digital modem 3. In this embodiment of the invention transmission is being carried out under a V.92 telecommunication transmission standard in which the analogue

voltage levels are transmitted in a one dimensional constellation which is indicated generally by the reference numeral 10 in Figs. 2 to 5. Constellation points in the respective constellations 10 are illustrated by lines 11*a*, 11*b*, 11*c*, etc., each of which represents a different analogue voltage level of the signal transmitted by the analogue modem 2. During initial hand shaking between the analogue modem 2 and the digital modem 3 the number of constellation points 11 is determined, and the codec 4 selects and correlates the constellation points 11 with corresponding codec levels 12 which are indicated in Figs. 2 to 5 by the lines 12*a*, 12*b*, 12*c*, etc., which correspond with the constellation points 11*a*, 11*b*, 11*c*, etc. As can be seen from Figs. 2 to 5 corresponding constellation points 11 and codec levels 12 may or may not coincide with each other, and whether the constellation points 11 and the codec levels 12 coincide depends on the number of constellation points selected.

In accordance with the invention the constellation points are selected so that the mid points 15 between pairs of adjacent constellation points 11 coincide with corresponding mid points 16 between pairs of adjacent codec levels 12. In other words, the mid point 15*a*, between constellation points 11*a* and 11*b* should coincide with the corresponding mid point 16*a* between the corresponding pair of adjacent codec levels 12.

Referring now in particular to Figs. 2 to 5, in Fig. 2 the number of constellation points 11 is similar to the number of codec levels 12. In this case, six constellation points 11*a* to 11*f* and six codec levels 12*a* to 12*f* are provided. The mid points 15 between the pairs of adjacent constellation points 11 are chosen to coincide with the mid points 16 between the corresponding pairs of adjacent codec levels 12. In other

words, the mid points 15*a*, 15b, 15*c* ..... etc. between the adjacent pairs 11*a* and 11*b*, 11*b* and 11*c*, 11*c* and 11*d* ..... etc. coincide with the mid point 16*a*, 16*b*, 16*c* ..... etc. between the codec levels 12*a* and 12*b*, 12*b* and 12*c*, 12*c* and 12*d*, ... etc. In Fig. 2 as can be seen the constellation points 11 coincide with the corresponding codec levels 12.

However, in Fig. 3 four constellation points 11*a*, 11*b*, 11*c* and 11*d* are selected while there are eight codec levels, namely, 12*a* to 12*h*. However, in accordance with the invention the mid points 15 between the pairs of adjacent constellation points 11 coincide with mid points 16 between pairs of adjacent codec levels 12. In Fig. 3 none of the constellation points 11 coincide with any of the codec levels 12.

Referring now to Fig. 4 three constellation points 11*a*, 11*b* and 11*c* are selected and eight codec levels, namely, 12*a* to 12*h* are provided. In this embodiment of the invention the mid points 15*a* and 15*b* of the constellation points coincide with mid points 16*a* and 16*b* of the codec levels 12. Additionally, in this selection of codec points the codec points 11*a*, 11*b* and 11*c* coincided with codec levels 12*a*, 12*d* and 12*g*.

Referring now to Fig. 5 the constellation 10 comprises three constellation points, 11*a*, 11*b* and 11*c* and nine codec levels 12*a* to 12*i* or provided. Again the constellation points are selected so that the mid points 15*a* and 15*b* of the constellation 10 coincide with mid points 16*a* and 16*b* between the codec level 12*c* and 12*d*, and 12*g* and 12*h*. In this embodiment of the invention none of the

constellation points 11*a*, 11*b*, and 11*c* coincide with any of the codec levels 12*a* to 12*i*.

Each constellation 10 may be fully described by the respective mid points 15 and one constellation point. Accordingly, since the mid points 15 of the constellation coincide with mid points of the codec levels, the mid points 16 of the codec levels 12 which coincide with mid points 15 of the constellation 10 can readily easily be identified in a bit mask by setting a bit in the bit mask to indicate that the corresponding mid point between adjacent codec levels coincides with a mid point in a constellation, and clearing the bit to indicate that no such corresponding mid point in a constellation appears.

The advantages of the invention are many. By selecting the constellation points so that the mid point between pairs of adjacent constellation points coincide with mid point between pairs of adjacent codec levels the affect of noise and distortion to the signal is minimised. For example, in Fig. 2 the noise margin is half the distance between the codec levels 12. In Fig. 3 two codec levels 12 are associated with each constellation point 11. Accordingly, if codec levels 12*c* or 12*d* are received, and if the distortion is completely random, and if all points are equally likely to be transmitted, then it can be assumed that constellation point 11*b* was transmitted. Thus, in this case the noise margin is equal to the distance between codec levels. In Fig. 4 where the adjacent constellation points 11 are spaced-apart to the amount of three codec levels 12, the codec levels 12 which coincide with the constellation points 11 have a better noise margin.

In Fig. 5 where four codec levels 12 are provided between pairs of adjacent constellation points 11 the mid level points are best. The constellation points 11 need not necessarily coincide with codec levels 12, however, it is essential that the mid points 15 between the adjacent constellation points 11 should coincide with the mid points 16 between pairs of adjacent codec levels 12. This causes the codec to quantise the noise/distortion in the most advantageous direction when a decision is being made in selecting a particular constellation point. Mid level constellation points, in other words, constellation points half way between two codec levels are not the only way of having decision points, in other words, the mid points between the constellation points that are also mid level points. Many other inter-level constellation points can also be optimal. This is because the codec level spacing is not uniform.

The situation, however, becomes a little more complex, when the constellation points are dependent on each other in some way, for example, when trellis coding is used. But the principle according to the invention still holds.

There is a further consequence of this for ITU-T recommendation V.92. In V.90, the constellation points are transmitted during the handshake. There are at least 512 possible constellation points in V.92 upstream. This is because each codec level is a possible constellation point and each mid point, between levels, is also a possible constellation point. The number of possibilities becomes even greater when the non-uniform spacing is taken into account. There are only 25 or so possible mid points between codec levels, and since all decision points should correspond to a mid point, there is less information to transfer if the decision points namely, the mid

points are transmitted rather than the constellation points. To enable the constellation points to be calculated by the transmitter, one constellation point, for example, the largest or the smallest should also be transmitted.

In V.90, the positive constellation points are described by transmitting a 128 bit mask with a bit set if the corresponding point is to be used as a constellation point and cleared if it is not. The negative points used are the negative values of the positive constellation points.

For V.92 upstream, the constellation points could be transmitted by sending a 128 bit mask. In the mask, a bit would be set to indicate that the corresponding mid level point is a constellation decision mid point, and cleared to indicate that it is not.

The required single constellation point could be indicated by a point number with a bit to indicate whether it is that point or the mid point below it.

Accordingly, when the distance between constellation points is less than or equal to the distance between codec levels, then the constellation points could be chosen to be equal to the corresponding codec level. In which case, a selection of the type illustrated in Fig. 2 would be selected. Otherwise, the appropriate number of constellation points may be selected corresponding to the number of codec levels provided.

The invention is not limited to the embodiment herein before described which may be varied in construction and detail.

F.F. GORMAN & CO.

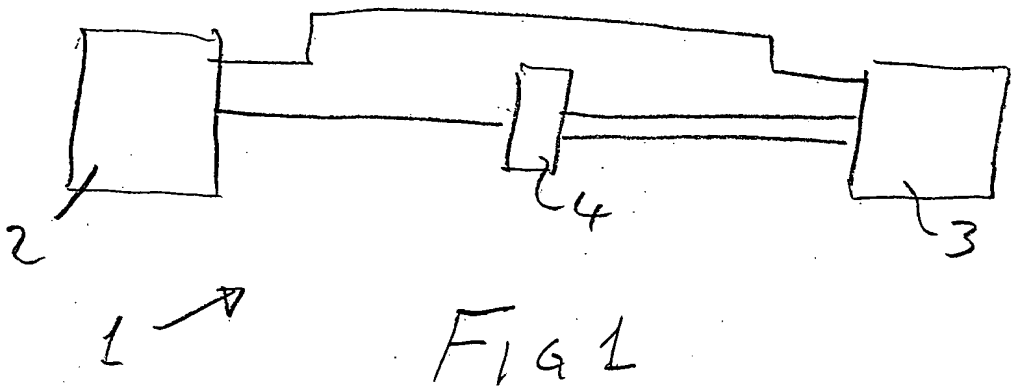


FIG 1

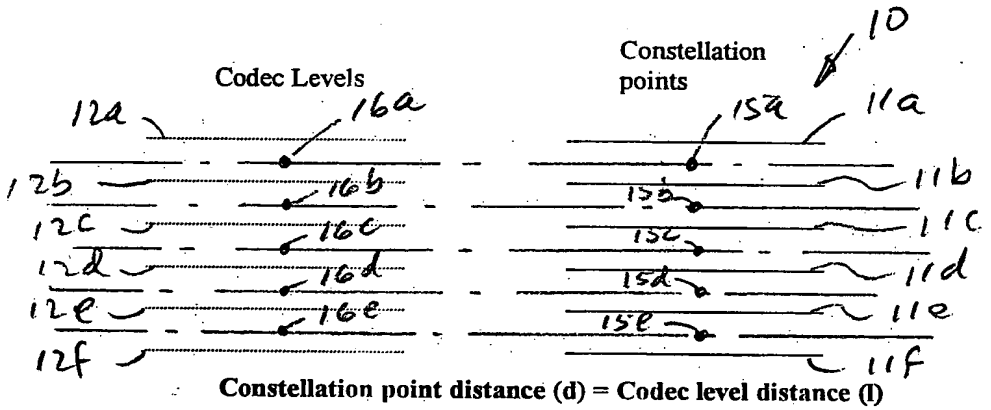


FIG 2

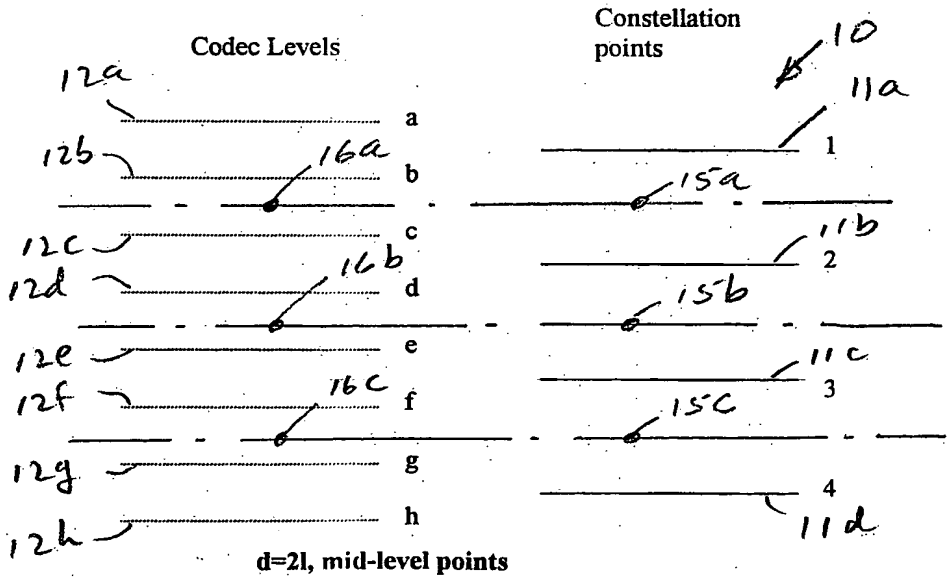


FIG 3

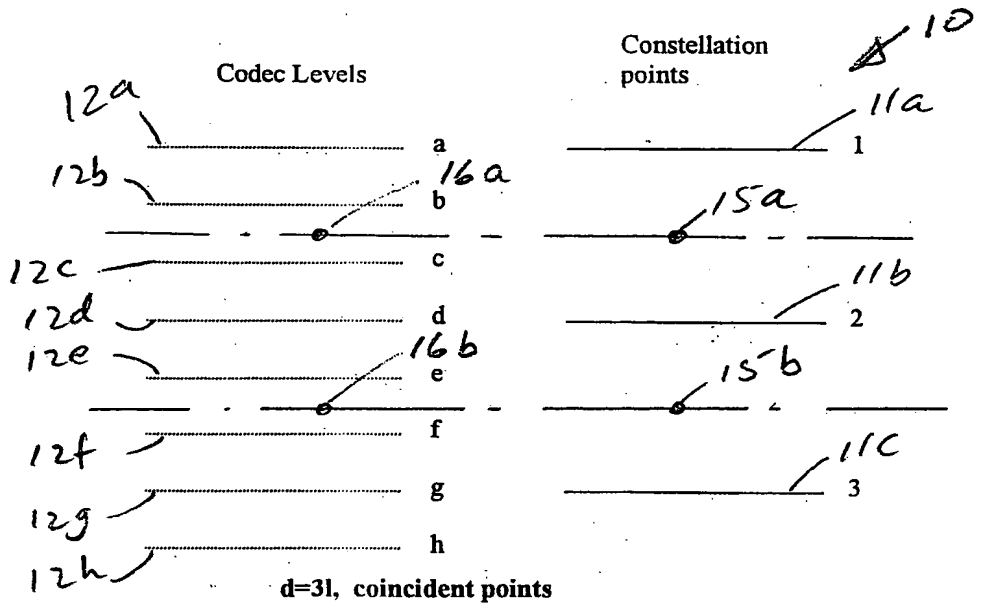

Codec Levels
Constellation points
10
12a
12b
12c
12d
12e
12f
12g
12h
a
b
c
d
e
f
g
h
16a
16b
15a
15b
11a
11b
11c
1
2
3
d=31, coincident points

FIG 4

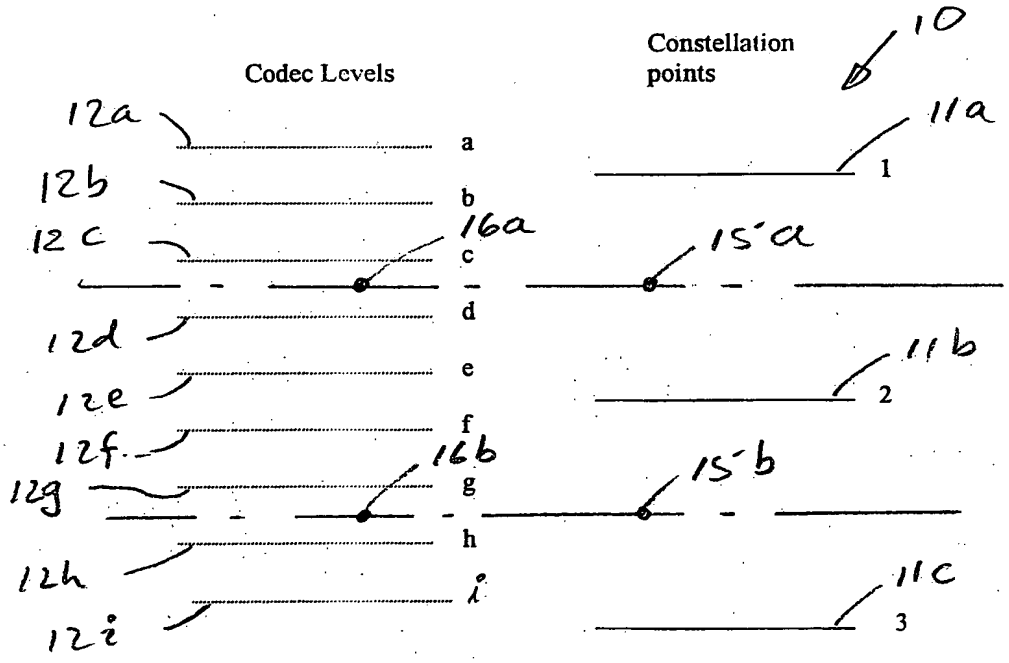

Codec Levels
Constellation points
10
12a
12b
12c
12d
12e
12f
12g
12h
12i
a
b
c
d
e
f
g
h
i
16a
16b
15a
15b
11a
11b
11c
1
2
3
d=41, midlevel points

FIG 5